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THE IMPACT OF WEATHER ON AVIATION SAFETY

REPORT

OF THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

OF THE

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION

U.S. HOUSE OF REPRESENTATIVES

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FOREWORD

In 1983, 289 million passengers took to the skies over the United States aboard commercial air liners. For most of these passengers, whether they were on business or on vacation, air travel was not a luxury—it was a necessity. These passengers expected that their safety would be protected by the most modern technology and the most exhaustive human procedures. With hundreds of lives at stake in almost every flight, air passengers assume that all possible steps will be taken for their safety. Unfortunately, they are not always right.

The hearings, which resulted in this report, clearly demonstrated that there have been numerous accidents and near-accidents because of the failure to communicate simultaneous weather information to the pilots of the aircraft involved. To this committee, there is no excuse for this failure when the technology exists to alert pilots of the necessary information. It is disturbing, to say the least, that the Federal Aviation Administration would decide to conduct another study rather than mandate the immediate application of the findings of previous studies. With thousands of passengers flying every day, even one day's delay in the implementation of proven technology risks too many lives.

The Committee on Public Works and Transportation first assumed oversight authority for aviation safety in 1975. The initial aviation study by the Subcommittee on Investigations at that time involved the subject of weather. It is unfortunate that airline passengers still may not have all the protection that is possible.

Subcommittee Chairman Elliott H. Levitas and Ranking Minority Member Guy V. Molinari are to be commended for pursuing this investigation after almost a decade. The document produced by the Subcommittee will serve as a guide for federal agencies that must take immediate action. It should be mandatory reading for anyone concerned with aviation safety. This Committee will undoubtedly be using the report as a benchmark to judge the performance of federal agencies in future oversight efforts.

JAMES J. HOWARD,
Chairman, Committee on Public Works
and Transportation.

LETTER OF TRANSMITTAL

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION,
U.S. HOUSE OF REPRESENTATIVES, ROOM 2165,
RAYBURN HOUSE, OFFICE BUILDING,
Washington, DC, November 26, 1984.

Hon. JAMES J. HOWARD,
Chairman, Committee on Public Works and Transportation, U.S. House of Representatives, Washington, DC.

DEAR MR. CHAIRMAN: The Subcommittee on Investigations and Oversight completed in this Congress an extensive and in-depth examination of the impact of weather on aviation safety. This inquiry began, as you will recall, in the 97th Congress but was temporarily sidetracked because of the subcommittee's focus on the safety of the nation's air traffic control system following the walkout by the members of the Professional Air Traffic Controllers Organization in August 1981.

The subcommittee hearings examined this matter from every possible approach, and the witnesses represented a realistic cross-section of all the appropriate parties involved, from the initial gathering of weather information through the process of disseminating the vital data to those who need it most—the cockpit crew.

The testimony clearly evidenced that much remains to be accomplished to ensure that accurate and timely information regarding dangerous weather cells is available in an understandable form before an unsuspecting aircraft is beyond the point of no return. We learned that weather is a formidable foe for even the most sophisticated aircraft, and that, in the case of newly identified weather phenomena, an unsuspecting pilot reacting to his training on how to handle an aircraft in turbulence, may unwittingly make the wrong decision.

I am pleased to forward the attached report which summarizes the results of that effort and contains the subcommittee's conclusions and recommendations.

It is our belief that you will find this report to be informative, objective, and perhaps the only document presently existing which sets forth the seriousness of the problem, the stumbling blocks which have hindered any real progress in achieving real time dissemination of weather information up to this time, and some realistic recommendations to improve the dismal record reflected in the hearing testimony.

With best wishes, I am,

Very truly yours,

ELLIOTT H. LEVITAS,
Chairman, Subcommittee on Investigations and Oversight.

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INTRODUCTION

Aviation safety is significantly impacted by weather conditions. This situation has existed over several decades despite governmental efforts—primarily by the Federal Aviation Administration (FAA) and the National Weather Service (NWS)—to improve the quality and availability of weather information through organizational and operational changes and research and development activities.

Weather has long been known to be a contributing factor in about 40 percent of air accidents. Air carrier accidents get the most public attention, but general aviation accidents result in the most casualties. Adequate and timely weather information is not reaching the pilot in the cockpit; often pilots do not get the hazardous weather information available from NWS. This subcommittee brought attention to the problem in our 1975 hearings. Because of subsequent lack of progress, we felt impelled to hold the hearings in 1981 and late 1983 that are summarized in this report.

1975 HEARINGS

In our 1975 hearings on the impact of weather on air safety, the National Transportation Safety Board (NTSB) identified weather as a causal factor in 295 of 840 accidents (about 35 percent) from 1962 to 1974 involving 1,175 fatalities. Several major air carrier accidents were identified as weather caused: an Eastern Airlines flight encountering wind shear (sudden change in wind velocity and direction) while landing at New York; an Ozark Airlines flight encountering a downdraft while landing at St. Louis; and an Iberian Airlines plane running into wind shear at Boston. Some of the findings of these hearings include:

More real-time weather information is needed in the cockpit, particularly in the terminal area;

The precise location of thunderstorms and associated wind shear is difficult to accurately predict;

Weather information available on the ground is often not communicated to the aircraft;

Pilots should retain the responsibility for decisions regarding weather avoidance;

Air traffic control (ATC) radars are designed to tone down weather images and highlight aircraft;

Adequate wind shear detection and alarm equipment is needed since many accidents are caused by wind shear;

General aviation has some unique weather-related problems; for example, general aviation planes fly in weather the whole route, unlike commercial carriers which usually fly above the weather en route.

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These comments made in 1975 illustrate the life-costing criticality of unavailable or misleading weather information, the weak links in communications and observation that prevent the transmission of timely and accurate weather information and the inability of federal agencies to improve this situation. These hearings thus provided a baseline record against which our 1981 and 1983 hearings could assess progress. In retrospect, it is disturbing how many of the same types of weather-related accidents have occurred since then and how federal programs have not yet mitigated such accidents.

Background

This section describes how weather is observed, forecasted and disseminated to pilots, and the associated improvements being sought through research and development. Trends in weather-related accidents are described and examined as to type of weather involved, and whether the pilot knew of the weather severity.

Providing weather information to pilots is a complex process beginning with weather observations from several sources (including satellites, radar, and visual), analyses to develop forecasts, and numerous communication links to disseminate weather information to pilots. The lay person is bombarded with acronyms for weather messages and forecasts, communication systems, bureaucratic identities, and research and development programs which hinder his understanding. In the following pages we will try to provide enough information to permit an understanding of this hearings summary.

THE PATH FROM WEATHER OBSERVATION TO PILOT DECISION

The path from weather observation to forecasts, transmitted via numerous dissemination routes to pilots, is a lengthy, tortuous course. Weather observations and forecasts are primarily the responsibility of NWS in the National Oceanic and Atmospheric Administration (NOAA). Dissemination of this weather information is primarily the responsibility of FAA in the Department of Transportation (DOT). Pilots of commercial air carriers and those general aviation (GA) pilots that choose to use Instrument Flight Rules (IFR) come under jurisdiction of FAA's air traffic control system. Those general aviation pilots that choose Visual Flight Rules (VFR) do not come under this system. Under VFR, the pilot, rather than the controller, is responsible for separating his aircraft from others.

The rest of this subsection describes the flow of weather information. Weather observations (from left to right in Figure 1) are taken by satellites, balloon sensors, weather radars, and ground sensors. All except satellites are managed by NWS; the National Environmental Satellite, Data, and Information Service (NESDIS) in NOAA directs the earth-orbiting satellite system. The aviation community contributes to weather observation through pilot reports (PIREPs) of weather conditions encountered, and through FAA's Flight Service Stations (FSSs), which make ground observations at airports.

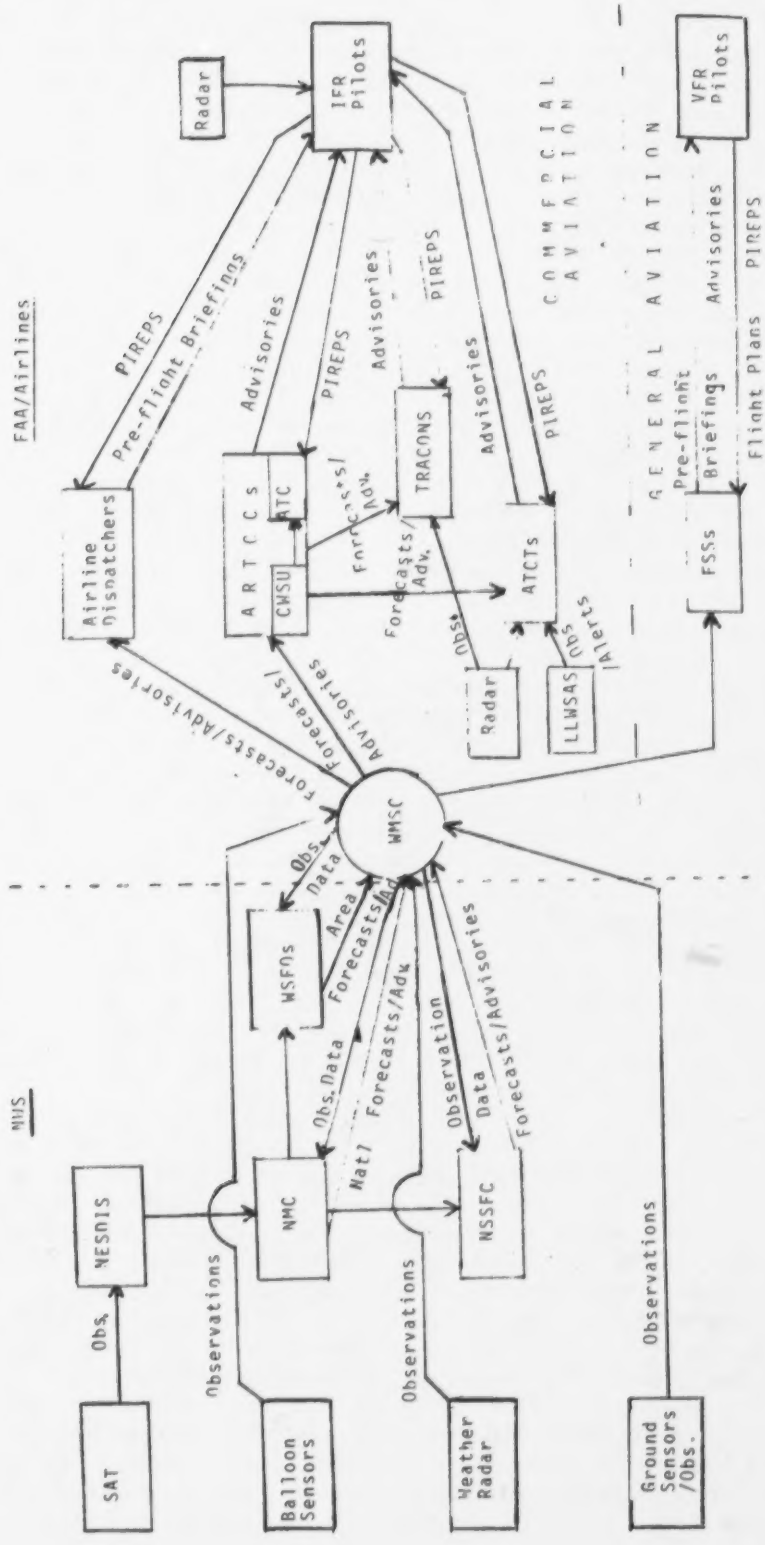

FIGURE 1: AVIATION WEATHER INFORMATION "SYSTEM"

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Weather observations are communicated directly to FAA's Weather Message Switching Center (WMSC) at Kansas City, the hub of the air-weather communications system. These basic data are immediately transmitted to principal NWS offices, including those involved with aviation weather: the National Meteorological Center (NMC) at Camp Springs, Md., which provides large-scale regional, hemispheric and global forecasts; Weather Service Forecast Offices (WSFOs)—52 in number, essentially 1 per state—which issue small-scale forecasts, including en route and terminal forecasts, weather watches and warnings, and other products for redistribution through WMSC to aviation users; and the National Severe Storms Forecast Center (NSSFC) at Kansas City, which prepares specialized forecasts and watches/warnings of tornadoes and severe thunderstorms. NWS's weather advisories include significant meteorological information (SIGMETs) pertaining to severe storms and, for the most severe storms, convective SIGMETs (CSs), which describe tornadoes, lines of thunderstorms, and level 5/6 storms on a scale of 1–6. Airman Meteorological Information (AIRMETs) represents an NWS advisory for conditions less severe than those requiring a SIGMET.

The WMSC transmits these NWS forecasts and warning products to FAA facilities through both a medium-speed Leased Service A teletype network and remnants of an older system of slow-speed teletypewriters.

FAA generally disseminates weather information differently for general aviation than for commercial air carriers, the former being the principal user of VFR and the latter being the principal user of IFR, which falls under the air traffic control system.

FAA's Flight Service Stations provide the principal weather information link to general aviation. FSS weather services include preflight weather briefings to pilots (in person or, more frequently, by telephone), air/ground radio contact for information or emergencies, and dissemination of en route and terminal weather information. Local NWS offices also conduct preflight weather briefings, particularly in areas where FSSs are not available. Although these services are available to all pilots, GA pilots are the primary users because air carriers have company dispatchers to conduct preflight briefings, and the ATC system to provide hazardous weather information en route and at terminals.

The FSS's specialized services include prerecorded weather information accessible by telephone and an En Route Flight Advisory Service (EFAS). Prerecorded services include: the Pilot Automatic Telephone Weather Answering Service (PATWAS), a continuous telephone recording of weather data prepared and frequently updated by an FSS specialist; and Transcribed Weather Briefings (TWEB) which have the same information as PATWAS, *plus* radar, surface observations and PIREPs. The EFAS provides real-time hazardous weather information and advisories to en route pilots on request, using both NWS weather forecasts and PIREPs.

The major responsibility of the ATC system is to separate aircraft by setting routes, altitudes, and separation distances; the provision of hazardous weather information to air carriers en route is an additional responsibility. IFR aircraft must be separated from each other and from VFR aircraft. The controllers' Air Route Sur-

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veillance Radars (ARSR) are designed to suppress weather observations in favor of identifying aircraft; only by switching to a secondary position on the scope can a controller superimpose "H's" on his screen to show hazardous weather cells. In bad weather, the work load on the ATC system increases, but the main priority then is the rerouting of traffic and the separation of aircraft, not necessarily the notification of pilots of hazardous weather.

The Air Traffic Control System is the principal link in FAA's dissemination of weather information to commercial air carriers, and consists of: (1) Air Route Traffic Control Centers (ARTCCs), which control en route traffic, (2) Terminal Radar Controllers (TRACONs), who control approaches to airports and who are usually located at the airports; and (3) Air Traffic Control Towers (ATCTs) which control takeoffs, landings and runways (all shown in Figure 1). FAA regulations require that commercial carriers provide their own dispatchers to give preflight weather briefings and provide en route weather information. In practice, however, only a few airlines provide en route information to their pilots.

The collection and dissemination of weather information in the ATC system begins in the Center Weather Service Unit (CWSU) housed in the ARTCC and manned by NWS meteorologists. The CWSU is a recent addition to the air weather system, resulting from a cooperative FAA/NWS program to improve weather information following the weather-caused crash of a Southern Airways DC9 aircraft at New Hope, Ga., in 1977. The CWSU uses the NWS forecasts and advisories transmitted from the WMSC, the new color radar called Radar Remote Weather Display System (RRWDS), and PIREPs from pilots via controllers to develop weather forecasts and advisories pertinent to the ARTCC's assigned air space. The CWSU provides these advisories as needed, plus regular weather briefings to ARTCC supervisors and controllers, as well as telephone briefings and advisories to TRACONs and ATCTs.

For major U.S. airports, the FAA has installed a Low Level Wind Shear Alert System (LLWSAS) on airport grounds to alert the towers when horizontal wind shear is encountered. For other types of weather, the ATCT and TRACON depend on information from the CWSU, supplemented by PIREPs, Airport Surveillance Radars (ASRs), and visual observation.

An Automated Terminal Information Service (ATIS) has been installed at major airports to provide weather information to approaching aircraft. The ATIS message is manually recorded by a terminal controller and continuously broadcast on a select frequency.

Finally, and most importantly, IFR and VFR pilots receive weather information from all these NWS/FAA/airline efforts and add their own observations from visual sightings and on-board radar (if so equipped). However, the "X" band aircraft radar is susceptible to attenuation by rain and ice, and thus might not penetrate a storm to depict the weather conditions beyond. The pilot retains the authority to decide whether to take an alternative course of action in the face of adverse weather conditions; he is the ultimate, and most important, recipient of weather information.

RESEARCH AND DEVELOPMENT

Federal agencies—primarily FAA and NWS—are researching, developing, testing and evaluating a number of ambitious, comprehensive systems to improve the observation, forecasting, processing, communication and dissemination of weather information. These activities are coordinated among the federal agencies involved and are reported to Congress in an annual Federal Plan by the Federal Coordinator for Meteorological Services and Supporting Research, located in the Commerce Department.

The Next Generation Weather Radar (NEXRAD) is the principal system development expected to improve detection of hazardous weather. NEXRAD is in the final stage of test and evaluation, with full scale production and installation planned for 1987–92. The final system will consist of about 160 Doppler radars which will provide weather condition coverage above 10,000 feet for the whole U.S. NEXRAD is an interagency project of the Departments of Commerce, Defense, and Transportation, begun in 1979 when the Joint System Program Office (JSPO) was established. Its aviation products will include wind and wind shear, clear air turbulence (CAT), thunderstorm detection, precipitation, freezing levels, tornadoes, and hurricanes.

The Terminal Doppler Radar Program is a result of Doppler weather research conducted for the past 10 years and tested in the Joint Airport Weather Study (JAWS) Project in Denver, Colorado. JAWS has been an intensive effort to analyze and predict thunderstorms and associated wind shear, microbursts, heavy precipitation, turbulence, and lightning. The Terminal Doppler Radars are expected to provide an important advance in detection and short-term prediction of such thunderstorm-related phenomena. FAA plans to install these radars at major airports where wind shear conditions are known to be common. Terminal Dopplers will differ in several ways from NEXRAD Dopplers; they will operate at shorter ranges with more rapid update and will provide greater emphasis on wind shear detection.

Another weather observation improvement under development is FAA's Automated Weather Observing System (AWOS), which will employ meteorological sensors, computers, and transmitters to take and disseminate basic weather data measurements from approximately 750 airfields. This system is now being tested at 14 U.S. airports, and full production is scheduled to begin in 1985. The AWOS sensors will measure wind, temperature, dew point, pressure, precipitation, visibility, and cloud height. The principal advantage of AWOS is that it is expected to provide lower cost and more reliable weather observations at more sites than can be covered today using human observers.

Greater efficiency is also being sought in weather information dissemination. A major system development affecting the Flight Service Stations is the Flight Service Automation System (FSAS). FSAS is expected to reduce the need for flight service specialists by automating the full range of FSS services, including pilot weather briefings, flight plan filing, en route weather information and emergency assistance. The implementation of FSAS, just recently underway, calls for reducing the number of FSSs from more than

300 today to just 61 when the stage-by-stage installation reaches completion in about 1989.

An important enhancement to the FSAS is the Automated Route Forecast (ARF) Program which is designed to replace area forecasts with more specific route-oriented forecasts. This NWS program has been tested and demonstrated, and development is underway.

A project that portends en route radio automation under FSAS is the Hazardous Inflight Weather Advisory Service (HIWAS). The FAA southern region tested HIWAS through a continuous broadcast of hazardous weather information (SIGMETs, CSs, AIRMETs, and urgent PIREPs) over a selected channel, simultaneously discontinuing the existing practice of having controllers and EFAS specialists provide such information. This HIWAS test became one of the topics of our hearings.

The Central Weather Processor (CWP) is a kind of automation counterpart to the FSAS, involving the Air Traffic Control System. The CWP will attempt to integrate information from various weather observation and forecast sources, and to automate the processing and dissemination of that information in the CWSU on a near real-time, or right-now-existing, basis. Each ARTCC will have a processor to serve the aviation weather users in its area—CWSU meteorologists, air traffic controllers, FSS specialists, and pilots. The CWP will be expanded in stages as related R&D developments become available; for example, the system will be modified as Doppler radar replaces the RRWDS; also, the CWP will be expanded when the Mode "S" data link becomes available to provide visual display of weather information in the aircraft cockpit. Mode S, the advanced air traffic control ground-to-air digital communication system, is scheduled to replace the current communications system in the late 1980s. The CWP is in an early stage of development with implementation expected in the ARTCCs in 1990 or 1991.

Another research project contributing to CWSU improvement is the Program for Regional Observing and Forecasting Services (PROFS), recently developed and tested in Boulder, Colorado, by NOAA with FAA support. PROFS provided the Denver CWSU with improved short-term forecasts of wind shifts, severe thunderstorms, turbulence, and low-visibility.

ACCIDENTS RELATED TO WEATHER

Information on the effects of weather on air accidents is limited and somewhat dated, despite a long history of hazardous weather conditions contributing to general aviation and commercial accidents. Available information indicates a problem of extensive magnitude in general aviation and commercial air carriers.

General Aviation

At our 1981 hearings, NTSB Chairman James King testified that approximately 40 percent of fatal accidents in general aviation involved weather, a percentage that holds true for both the 1964–72 and the post-1975 period.

The table below shows the principal weather phenomena involved in fatal accidents

GENERAL AVIATION: AVERAGE ANNUAL NUMBER OF FATAL ACCIDENTS

	1964–72	1975–79
Low ceiling	145	157
Fog	90	108
Rain	59	55
Snow	27	30
Turbulence with thunderstorms	21	19
Thunderstorms	19	28
Icing	17	26
Downdraft/updraft	13	14

Extrapolated from: National Transportation Safety Board, Special Study of Fatal, Weather-Involved, General Aviation Accidents, August 28, 1974, Table 19, page 13. Federal Coordinator for Meteorological Services and Supporting Research, National Oceanic and Atmospheric Administration, A Report on Nexrad: National Airspace System Cost/Benefits, June 1983, table 2-1, page 2-9; table 2-3, page 2-10.

In six of these eight weather categories, the average annual number of fatal accidents increased from the 1964–72 period to the 1975–79 period. The first two categories—low ceiling and fog—accounted for about 60 percent of fatal accidents in both periods.

For accidents *not* resulting in fatalities, a different weather phenomenon is involved—unforeseen winds. Unforeseen winds account for 253 accidents per year in the 1975–79 period—63 percent of all such accidents.

Pilots in weather-related accidents often did not follow standard procedures. In the 1964–72 period, 62 percent of GA pilots in weather-related accidents had not filed flight plans, and 28 percent had not received weather briefings.

Air Carriers

Chairman King of NTSB testified that since 1975, 52 percent of the fatal air carrier accidents involved weather as a contributing factor. No comparable data were presented for the pre-1975 period.

Material submitted for the record at our 1975 aviation safety hearings indicated that low ceiling and fog are the main weather phenomena involved in *fatal* air carrier accidents. These two categories account for 41 percent of air carrier accidents in the 1962–74 period. For *non-fatal* accidents, air turbulence and thunderstorms accounted for 60 percent of weather-related accidents from 1962 to 1974.

Commercial air carriers experienced a decline in both fatal and non-fatal weather-related accidents from the 1962–74 period to 1975–79. Fatal accidents fell from six to four per year, and non-fatal accidents declined from 27 to 16.

Hazardous Weather Phenomena: Microburst and Wind Shear

At 2:04 PM on the afternoon of August 1, 1983, Air Force One, with President Reagan aboard, landed at Andrews Air Force Base southeast of Washington, D.C. At 2:12 PM, Andrews was struck by peak winds exceeding 120 miles per hour, followed by a number of gusts above 90 miles per hour.

Flight information at the time depicted a thunderstorm west of the airfield moving to the northeast. Air Force One had landed uneventfully and was shut down on the ground when the storm struck. Three Air National Guard jet aircraft and an F-4 fighter

plane were damaged and part of the roof of an airport building was peeled off.

The storm was accompanied by a narrow band of rain and ¼" to ½" hail. Corn plants nearing maturity were ripped out of the ground southwest of the airport.

By only eight minutes, Air Force One had avoided a microburst, one of the most deadly weather phenomena known to meteorologists.

A microburst, as discussed at subcommittee hearings by Dr. Theodore Fujita, Professor of Meteorology at the University of Chicago, and Dr. John McCarthy, Director of the Joint Airport Weather Studies Project (JAWS) at the National Center for Atmospheric Research, is a powerful downward blast of air usually associated with a thunderstorm or rain, followed by a violent horizontal burst of air in all directions, or, wind shear.

Microbursts are extremely dangerous because their area is relatively small—normally 2½ miles in diameter or less. They are short-lived—95 percent of microbursts reach maximum intensity in 10 minutes and are difficult to detect with existing technology. Indeed, by the time detection of a microburst is made in the terminal area, it is often too late to help a plane.

Upon entering a microburst in an approach-to-landing situation, a pilot would first encounter a rapidly increasing head wind, which would increase the airflow across the wings of the aircraft, increase the airspeed, and, if nothing else changed, would cause the aircraft to rise above the glide slope. If the pilot were unaware of the wind shear occurring, he might choose to throttle back to maintain a stabilized approach. At about this time, a downdraft would hit, accompanied by a strong tail wind, the magnitude of which might exceed the performance characteristics of the aircraft. Being in a powered-down mode precisely at that moment, he would need increased airspeed to counteract the performance-decreasing tail wind. The result might be, in Dr. McCarthy's words, "premature impact with the ground," otherwise known as a crash.

Microburst research began, according to testimony given by Dr. McCarthy, in 1976 following a June 1975 Eastern Airlines crash at JFK Airport. Eastern Flight 66 was pushed to the ground by a combination of downflow and loss of head wind, resulting in the deaths of more than 100 people. In August 1975, Continental Flight 426 encountered severe head wind followed by tail wind at Denver's Stapleton Airport. Despite pilot maneuvers, the aircraft was unable to climb above 100 feet, dropped next to the runway area, skidded and stopped.

Following the mid-1970s accidents, FAA developed a wind shear program office that led to a number of actions, one of which was the LLWSAS. At about the time that FAA disbanded the wind shear office, Dr. Fujita, Dr. McCarthy, Dr. Walter Frost, who had been conducting aviation weather problem workshops at the University of Tennessee Space Institute, and others in the scientific and aviation community, came together and agreed that the wind shear/microburst problem had not been adequately resolved. As a result, the JAWS Project was created in 1980, with initial funding provided by NSF, NOAA and NASA, and FAA funding in September of 1982.

The JAWS Project examined the structure, frequency and severity of microbursts, the effect of microbursts on aircraft performance, and the use of detection and warning systems. Of the 91 possible field research days in the JAWS Project conducted at Stapleton Airport, storms occurred on 78 days, microbursts were observed on 44 days, 70 microbursts were seen with selective use of Doppler radar, and 186 microbursts were observed by surface sensors operating 24 hours a day. (In testifying about the Air Force One microburst incident referred to earlier in this report, Dr. Fujita stated that preliminary analysis indicated that the severity of this microburst surpassed all microbursts observed during JAWS, ranking in the top one percent of severe microbursts he had ever studied.)

JAWS resulted in a number of recommendations regarding wind shear and microbursts, which Dr. McCarthy detailed at the hearings:

the need for improved pilot and controller awareness;

the need for improved flight procedure training for pilots, with emphasis on procedures to get through wind shear, should avoidance fail;

the need to improve and record the low level wind shear alert system;

the need to develop and improve airborne detection and warning systems;

and the need to develop an integrated wind shear program.

As was stated again and again by hearings witnesses, detection of hazardous weather is useless unless it is transmitted to the one who needs it most—the pilot. Perhaps Captain Patrick Clyne said it best in this exchange with Chairman Levitas regarding the 1982 Pan American Flight 759 crash at Kenner, Louisiana, and the failure of the air traffic control system to transmit a pilot report:

> Captain CLYNE. There is a historic problem within pilot-controller communications of getting pertinent data passed on to other pilots. This is not a—the incident that occurred here is not an isolated incident where you have a pilot report that is received by air traffic control personnel who for many reasons may choose not to pass it along.
>
> I would point out to you, however, that these microburst phenomena, if that is indeed what happened in Kenner, are very short-lived, certainly shorter than seven minutes. It is essential that the underlying training of controllers and pilots be enhanced and reinforced, that vital information is passed by the pilot to the controller, and the controller act as a conduit to get that information to other pilots.
>
> As imperial as that system is, it is the best that we have now until we come up with suitable onboard detection devices which would eliminate the need for that information transfer.
>
> Mr. LEVITAS. So it [a pilot report] is a very important source of information?
>
> Captain CLYNE. Absolutely.
>
> Mr. LEVITAS. We had a similar problem with the Eastern Flight 66 at Kennedy.

Captain CLYNE. It was a problem with Eastern 66, it was a problem with World 30 in Boston. Oftentimes the information is there. It just doesn't get passed.

Mr. LEVITAS. Well, I think you have underscored very graphically, Captain Clyne, the problems that we are looking at. . . .

RESEARCH AND DEVELOPMENT

FAA officials testified at our hearings in 1981 and 1983 that research and development (R&D) would improve weather observation and weather information dissemination, leading to better real-time weather information for pilots. We have found, however, that despite major R&D expenditures in the past, the record fails to show significant improvements in weather-related aviation safety. Aircraft continue to encounter hazardous weather conditions, which, although known on the ground, are not being communicated to pilots through "improved" dissemination systems resulting from R&D. The hearing discovered both R&D schedule slippages and R&D limitations, particularly with respect to focusing on the needs of pilots.

TWO YEARS IN LIMBO

A comparison of the R&D system description presented by FAA and NWS in our March/May 1981 hearings with presentations in August/December 1983, revealed that schedules on several major R&D systems slipped over this period. There was general agreement at the hearings that the next generation radar (NEXRAD) is a sorely needed advance in weather observation technology that would replace the obsolescent radars now in use, most of which are 20 to 30 years old. NTSB testified in favor of expediting this system. Mr. King testified in 1981 that the Doppler radar used in NEXRAD represents a technology that has been around since the 1960s and that could have been adopted considerably earlier than the planned delivery of the late 1980s. In 1981, FAA testified that NEXRAD implementation was planned for the late 1980s, beginning in 1985–86; in the 1983 hearings, FAA indicated that NEXRAD implementation is scheduled for the 1988–92 period—a two- to three-year slippage.

Two other systems to improve observations are now in the implementation stage but their completion dates are also slipping. The Low Level Wind Shear Alert System (LLWSAS), designed to detect critical levels of wind shear at airports, was reported in 1981 to have 58 systems under contract or installed with system implementation in the fourth of six years; in 1983, there were 59 LLWSAS systems in operation and 51 systems were to be added in 1984 and 1985—again, about a two-year slippage.

The color radar (RRWDS) displays six levels of weather intensity in different colors. In 1981, FAA reported that RRWDSs would be operational in all CWSUs and EFASs by "early next year"; but in 1983, FAA testified that this system would be operating in CWSUs/EFASs by June 1984—a two-year delay in promised implementation.

Slippages are not limited to observation systems; dissemination system plans are also being pushed back. FSS automation was billed as a high priority in both 1981 and 1983 because it would enable the Flight Service Stations to provide a more effective service on a more efficient basis. We were told by FAA that FSS automation began in 1972, and that a five-year development period was to begin in 1982. However, in 1983, we were told that the development period was to begin in 1984 and to be completed by 1989.

NADIN is a high-speed communication system designed to expedite both traffic control and weather information messages between the ARTCC and the terminals in its airspace—an important enhancement, since most of this communication is now by telephone. In 1981, FAA reported that a contract for NADIN had been awarded and that the "final system will be in place in 1982." But in 1983, FAA indicated that the "final phase" will be operational in 1984 and that all enhancements will be in place by 1987–88.

Thus, each of these five systems—NEXRAD, LLWSAS, RRWDS, FSS automation, and NADIN—show little or no progress over the two and one half-year period of our hearings. FAA did not ackowledge these slippages at our hearings; we discovered them from a review of the record. FAA and NWS provided us with no explanation for these delays. These delays are consistent with the comment of an NWS witness that "We have not seen a program come in on time in the 20 years I have been in the Weather Service."

A representative of the Aircraft Owners and Pilots Association, while indicating his frustration with FAA's long-existing failure to modernize the Flight Service Stations despite extensive planning, suggested that:

> This subcommittee may be able to assist the general aviation pilot, and all of aviation, in pointing out in this subcommittee's report that there is a need for moving along and discontinuing some of the studying that has been going on for years.

Chairman Levitas expressed the need to move from study to action in his opening statement prior to FAA's R&D presentation on December 6:

> I am hopeful it will be a blueprint for a positive commitment to action by the FAA, and not a repeat of past performances wherein other plans have frequently resulted in a continuing experimental program while searching for the ultimate system.

OPERATIONAL CONCERNS

The subcommittee would like to see operational payoffs from R&D. In particular, we would like to see those systems in place that provide better real-time weather information to pilots. The following discussion of the Hazardous Inflight Weather Advisory Service in the hearing illustrates our concern that this might not happen.

HIWAS provides hazardous weather messages through continuous broadcast over a select VOR channel, in lieu of controller broadcast advisories. HIWAS was tested by FAA in the Miami and

Jacksonville Center areas and declared successful, resulting in plans for immediate nationwide implementation. Chairman Levitas cited an incident in which a number of passengers were injured in November 1983 aboard an Air Canada flight which encountered severe air turbulence in that region. The Air Canada crew was unaware of the HIWAS system and thus had not tuned in to the assigned channel to receive the convective SIGMET issued 30 minutes previously. This situation led the Chairman to make the following statement when introducing the next day's hearing (December 7):

> Any time an agency pronounces a program as a success because it has been tested on two occasions does not mean it will become a success elsewhere. There must be continuing evaluation of the program by some manner of feedback from the client it is designed to assist. In the case we discussed yesterday, when 116 out of 116 pilots admit that they were not aware of the Hazardous Inflight Weather Advisory Service, it causes us great concern about the acronyms, the phrases, the charts and even the program itself now, which we learned of in the FAA testimony, because it may end up with similar results.
>
> Having a better mousetrap will not sell unless you market it to somebody who needs to use it.

We are concerned with what we perceive to be the many competing objectives of the R&D program—lower costs, system enhancements, improved weather observations and improved information for CWSUs, FSSs and controllers. Many of these objectives may lead to improved real-time information for pilots; others may not. We are not assured that the needs of the pilots themselves are systematically incorporated into the R&D systems. This was best expressed by a pilot who, in testifying about the HIWAS system, stated that "the design of this particular HIWAS system is just simply not responsive to the real-world problems that aviators have when they are operating normal line operations."

Weather Observations

The National Weather Service is the primary collector of weather data for aviation users. NWS witnesses at subcommittee hearings testified about weather data collection, dissemination, and research and development efforts slated to improve the weather data gathering process.

Weather observations are used for providing input to numerical forecast models at the National Meteorological Forecast Center and to meteorologists at field locations preparing terminal and area forecasts. Observation tools fall into four basic categories: weather radar, satellite photos, surface observations, and pilot reports (PIREPs).

Weather radar, with its ability to survey the growth, movement and decay of violent storms, is extremely important in identifying hazardous weather. NWS maintains a radar network that covers about 95 percent of the area east of the Rocky Mountains, and that gathers data from the Western U.S. through 22 FAA ARTCC

radars. Radar reports are made hourly, and more frequently when "significant" weather appears.

Geostationary operational environmental satellites are also important tools in the weather data collection process. Satellite photos, taken every 30 minutes, delineate areas of cloud cover and can often detect developing severe weather before it appears on radar screens.

Surface observations are taken at airports by airline or airport personnel, and at non-tower airports by flight service specialists and, in some cases, private contractors.

Forecasters also rely upon pilot reports. Certain critical phenomena, such as turbulence and icing, can only be observed from the cockpit. Thus, forecasters, controllers, pilot briefers, and other pilots, are dependent upon pilot reports for the knowledge of some hazardous weather phenomena.

During the hearings, NWS Deputy Director William Bonner acknowledged the need for improvement in these observation systems. Current weather radars, in Bonner's words, "are rapidly reaching the end of their useful lives." Next Generation Weather Radar (NEXRAD), a radar system employing both conventional and Doppler technology, is being developed to replace existing aging radars and to provide improved weather information.

To improve surface observations, NWS has embarked on an interagency program to automate the surface weather observing functions at stations which take aviation observations. One of the advantages of automation seen by NWS is that it would provide a continuous monitoring and readout of weather conditions, as opposed to the manually-intensive system of human observers who make hourly observations and make special observations "as required." Opponents of the automated observation system, however, such as flight service specialists, pointed out that the automated system can be misleading, as it will only give readouts for a small section of the sky directly above the weather sensor.

An NWS witness testified that a better means is needed for collecting and disseminating pilot reports, and that "Sometimes it is almost like pulling teeth to get pilot reports."

Mr. Edward Gross, NWS Domestic Aviation Program Leader, stated that although there is a standardized format for PIREPs, there is no systematic way of collecting such reports. At the time of the hearings, NWS was working with FAA and members of a subcommittee under the auspices of the Federal Coodinator for Meteorological Services and Supporting Research to develop such a plan.

Several related weather observation issues concerned subcommittee members: quality control of weather observations and planned budget cuts in NWS which could have a negative impact on aviation safety.

NWS retains the responsibility for quality control of weather observations. Mr. Bonner testified that NWS is involved in the training and certification of all people under contract who make weather observations in the country. He further stated that NWS conducts a verification program that monitors observation errors. However, Leo Harrison, Jr., National Weather Service Employees Organization (NWSEO) President, testified that much of the qual-

ity control program is done after the fact: "The observation has been out and used operationally, and it may be several weeks later before the errors are corrected."

NWSEO witnesses also testified that the quality of weather services would be adversely affected by the loss of accurate and timely weather observations with the closing of several stations by both NWS and FAA. Proposed alternatives to compensate for these closings, it was stated, would not maintain the present level of quality of services.

NWS maintained that proposed budget cuts would not impact on the quality of observations, but that there would, however, be an impact on the number of observations.

One exchange between Chairman Levitas and Mr. Bonner was particularly telling regarding the impact of the proposed personnel cuts in NWS:

> Mr. LEVITAS. Will the reduction of these 253 positions in the short term have an adverse effect upon the quality of weather information being provided for the air transportation system?
>
> Dr. BONNER. I think the best answer to this is that we will do everything we can to prevent this reduction of positions from having an adverse impact on aviation safety.
>
> Mr. LEVITAS. I am sure of that, Dr. Bonner. I have no doubt about that. You are the Deputy Director of the National Weather Service. You are an expert in this field. We are concerned about the quality of weather information because of its rather significant impact on aviation safety—and I understand your testimony was cleared through OMB?
>
> Dr. BONNER. Yes sir.
>
> Mr. LEVITAS. I understand that. But you are here testifying, and I need to have your answer to that question, if I may.
>
> Dr. BONNER. That—I would be happy to respond, Mr. Chairman, except that in a sense that requires a prediction. I can talk about the specific cutbacks and the specific losses in service. Those cutbacks were chosen, really, on the basis of trying to minimize the effects of cutbacks on safety, in aviation and other areas, and in any kind of decisions like that there is some level or risk, and we have tried to minimize it.
>
> Mr. LEVITAS. Well, the very choice, and the very careful selection of the word "minimize" suggests to me that there will be an impact, and therefore it is a question of making it less hurtful than it might otherwise be, by careful administration and management decisions.
>
> I am not going to push you any further on that. I think the picture is clear.

Subsequent questioning elicited the response from Dr. Bonner that the directive for the elimination of 253 positions came down through the Administration and was based on personnel levels or numbers, and not functional performances by individual personnel slots.

Chairman Levitas summarized the subcommittee's concern with personnel reductions made at the possible expense of safety:

> . . . I have said repeatedly, and I will say again now, that as we go through this process generally throughout the government, the worst place to begin is in the safety area, and I am very disturbed not just in this situation, but in several other instances, that I see reductions in force being made almost arbitrarily to the detriment of the health and safety of the American people, in this case, of the people who fly on commercial or private aircraft.

COMMUNICATIONS

Gathering weather data and preparing accurate forecasts is the initial step in providing a sound weather information system for the aviation community. With few exceptions, most notably the lack of weather observers at remote locations, the questionable quality of observations taken by contractors, and a sparcity of precise data from vast areas such as South America, Africa, and the ocean regions, hearing testimony indicated that the reliability of weather observations and forecasts—*at the time made*—is adequate, and will continue to improve as technology advances. The major problem, however, has been communicating current weather data throughout the system and disseminating it in a timely manner to pilots. As Chairman Levitas remarked during the hearings:

> One thing seems certain to me: There are a large number of people engaged in observing and submitting reports on weather. The problem remains how to get real-time data to the flight deck before they are in the midst of a severe weather cell. One word spells it all—communication.

Virtually every witness echoed this theme:

> Edward Gross of NWS acknowledged delays in data transmission from centers or Flight Service Stations to pilots;
>
> Lawrence Cushing, head of the National Association of Air Traffic Specialists indicated that the greatest area for enhancing aviation safety lay in getting timely and accurate data to the pilot;
>
> Jeff Bowman, flight dispatcher, testified that the 1957 vintage cathode ray tube system used to transmit weather forecasts is becoming more unreliable all the time with numerous breakdowns;
>
> Michael Simons, PATCO's air safety director, stated that controllers lack adequate administrative support and reliable equipment to pass along severe weather data to aircraft in flight;
>
> John Enders, the Flight Safety Foundation's president, emphasized that the problem is not so much a lack of information as the failure to put that information where it is needed at the appropriate time;

James King, NTSB chairman, recommended that action be taken to improve NWS's capability to detect rapid changes in real-time weather, and that communications be improved among NWS, en route and terminal air traffic control facilities, and pilots;

General John Ralph, Air Transport Association, stated that getting severe weather information into the cockpit is the most important requirement that remains to be satisfied in the national airspace system;

Captain Thomas Sheppard, ALPA, testified that although substantial progress has been made in reporting and disseminating weather data over the years, pilots today are still not getting accurate and timely information in the cockpit;

Captain Patrick Clyne, Northwest Airlines' Severe Weather Data Project coordinator, stated that the pilot flying today has little more in the way of real-time weather information available to him than did his predecessor of 20 years ago;

Elbert Friday, NWS's Acting Deputy Assistant Administrator, acknowledged delays in information transfer from NWS to FAA because of equipment incompatibility between the two agencies, but stated that this problem was "being aggressively attacked;"

Robert Hale testified that FAA recognizes a need for improvement regarding the dissemination of weather data.

Clearly, while accurate forecasting is essential for aviation safety, that in itself is not enough. Sudden and unforeseen changes in weather conditions, particularly the development of severe thunderstorms and wind shear conditions, and hazardous weather conditions in the terminal area, make it imperative that pilots be kept aware of actual "real-time" weather.

In the communications area—data transmission from the observation point to NWS and FAA circuits, Flight Service Stations, CWSUs and controllers for eventual transmission to the pilot—several major obstacles were identified, including obsolete, unreliable equipment and inconsistent terminology.

Witnesses from NWS and the NWS Employees Organization detailed problems with antiquated teletype systems transmitting weather data from the point of observation to weather stations and flights, and instances of cathode ray tube systems displaying data as much as two days old.

Disturbing testimony was received from NAATS witness Harry Duke regarding the Leased Service A System (LSAS) used in Flight Service Stations for data reception from FAA. In describing his hands-on experience with LSAS as "frustrating and depressing," Duke told the subcommittee of incidents in which equipment breakdown left Flight Service Stations without weather briefing capabilities for intervals from several hours to several days.

Another problem concerning effective communication raised during the hearings was the use of different terminology in transmitting weather information between centers and from center to pilot. An ATA witness asserted that the lack of uniform terminolo-

gy could be corrected through training, and cited the difficulty in passing information from person to person due to different perceptions and conflicting priorities. A Commuter Airline Association witness also identified inconsistencies in terminologies used by FAA and NWS.

Perhaps more disturbing was pilot unfamiliarity with weather terminology, as outlined by an ALPA witness. ALPA submitted for the record an analysis of weather-related considerations in selected aircraft accidents. One contributory factor identified by ALPA in the Southern Flight 242 accident on April 4, 1977, was the unfamiliarity of all pilots in the immediate area with terminology used by NWS to describe thunderstorm intensity.

Similarly, we learned from a preliminary NTSB investigation that all 116 pilots interviewed were unfamiliar with the existence of the HIWAS system being tested in the Miami-Jacksonville area to provide pilots with the continuous broadcast of hazardous weather information.

FAA acknowledged these communication deficiencies during the hearings and anticipated improvement through research and development programs and procedural changes.

At the hearings, Chairman Levitas described an event in which a pilot of a United Airlines flight departing National Airport in Washington, D.C. noted a large weather system on his weather radar display. The pilot asked the tower controller what his ATC radar showed and he replied that his radar was not showing weather activity. Inquiries subsequent to the event revealed that (1) the controller's weather radar display was not working and had not been working for about a year and (2) at the same time, Dulles Airport controllers (10 miles away) were advising that a significant storm cell was moving into the area. The Chairman concluded with a summary of this event:

> The United pilot, Flight 821, detected the activity. The controller that he was dealing with didn't know about it. Yet at Dulles air traffic control facilities, there was that information and they were broadcasting advisories relating to that same storm. Which means the information about the weather was in the system some place, but it wasn't in one of the places that it needed to be.

This, then, illustrates a lack of dissemination of known hazardous weather information, either from the CWSU unit in Leesburg, Va., or from the Dulles Airport Tower.

Flight Service Stations

Flight Service Stations (FSSs), numbering over 300 nationwide, are the primary source of weather and flight information for all of general aviation. This is a very important function, since most weather-related accidents and fatalities occur in general aviation. FSSs provide both preflight and en route weather information.

The equipment modernization and automation of FSSs has been in the planning stage since about 1970, but with little progress as yet. The type of equipment used, number of personnel, and types of services vary widely among FSSs, but the continuing prospect of

automation, which would reduce the number of FSSs from more than 300 to 61, tends to forestall interim measures to enhance existing stations. A couple of exceptions are the addition of both (1) Leased Service A equipment, a high-speed system to communicate NWS forecasts/advisories to FSSs, and (2) color radar (RRWDS) to be used by the En Route Flight Advisory Service (EFAS) personnel at the FSSs to provide real-time weather information to GA pilots upon request.

The FSS receives weather forecasts and advisories from NWS via the Leased Service A equipment, or the older teletype equipment if the FSS has not received Service A. The forecast and advisories are the same as those transmitted to the CWSU from the Weather Message Switching Center in Kansas City. In addition, the FSS should receive weather messages from its regional CWSU—usually by telephone. This weather information is used by FSS specialists to provide preflight weather briefings for GA pilots. The pilot usually files a flight plan by telephone with the FSS, which the specialist stores for reference in case of trouble. The 45 (or so) EFAS units in the FSSs respond to radio requests from pilots for (1) en route weather or other information, or (2) assistance in the case of emergency. The FSSs also receive and disseminate PIREPs, and broadcast SIGMETs and AIRMETs. (At many locations, FSSs provide weather observations as inputs to NWS forecasts/advisories.)

In addition to these labor-intensive services, selected FSSs provide automated services. One such service, the Pilot Automatic Telephone Weather Answering Service (PATWAS) provides a continuous recording of weather data prepared and updated by FSS specialists; another service, Transcribed Weather Briefings (TWEB) provide the same data as PATWAS, plus radar and surface observations as well as PIREPs.

For the pilot to obtain these FSS services, he must know of their existence and how to gain access to them. The pilot must know how to call for a weather briefing (or a transcribed weather briefing), or how to use the radio to reach the EFAS (or transcribed en route services). Also, the GA pilot flying under VFR rules must gauge the relationship between his flight path and the location of hazardous weather, since the location of the aircraft is not generally plotted on radar and guided by controllers as in the ATC system.

The National Association of Air Traffic Specialists (NAATS) stated in the 1981 hearings that:

> The FAA has dedicated the preponderance of its resources to the safety of scheduled air carriers and only a paucity of resources to the safety of general aviation and to the distribution of weather information . . . the FSS, by deliberate design, is and has been chronically understaffed, and the equipment in general use is woefully inadequate and is not presently capable of providing adequate or timely service to a majority of those who desperately need the services we should, but cannot, provide.

The Aircraft Owners and Pilots Association (AOPA) stated an even stronger position:

> The Flight Service Station is a victim of the bureaucracy . . . the equipment is garbage . . . and the morale of the Flight Service Station people is the pits.

During the 1981 hearings the FAA responded, in part, to such criticisms:

> Over the past two or three decades, the FSSs have not received the same attention as the terminals and the en route centers: this is true. We have been involved in automation of the flight service stations, or getting ready for it since the early 1970s, and it is just now that we are ready to proceed with a production contract.
>
> In 1972, we initiated automation for the flight service stations, as was mentioned by the NAATS representative, at Atlanta, Indianapolis, and Washington. There was a time delay in implementing that program nationally, as we are doing now, due to the problem of gaining the concurrence of all the parties involved—FAA, OST, OMB, the Congress, and the industry—as to what configuration that automation should take. That caused some delay in modernizing the FSS system.

However, the FAA did not address the specific FSS issues raised by NAATS and AOPA, such as understaffing, poor morale, inadequate equipment, and insufficient resources to provide adequate services. In our 1983 hearings, we heard once again that the FAA was ready to begin FSS automation—a slippage in addition to those mentioned in FAA's 1981 statement.

Testimony by the National Transportation Safety Board outlined problems encountered even by FSSs having Leased Service A equipment:

> Many flight service stations now have the Leased Service A weather system. This is a high-speed weather data system capable of receiving large amounts of weather data in a short time. However, despite this capability, important weather messages are often not received by the flight service station briefer in a timely manner. This was emphasized during the investigation of a crash involving a Beech Super King Air near Denver, CO, last year. The crash killed 10 persons. This deficiency prompted the Safety Board to issue another recommendation to the FAA regarding the transmission of urgent weather messages.

Another witness commented quite graphically on the operational difficulties of using printouts from the Leased Service A equipment to give pilot briefing:

> Mr. Levitas. You remarked that most of your time is spent in editing rather than providing services. Can you give us sort of an example or provide us some sort of portion of your time which is devoted to editing? Is there a solution to this problem? How can we deal with it?
>
> Mr. Duke. It might be done in the programming. When I said 18 feet, that was it exactly. I measured it. A bunch of us in the station just couldn't believe it when that thing

> started to hum, and the next thing you know he has got one end and we are pulling it across the room. It was 18 feet long. If I have got a pilot calling me and he wants to fly from Atlantic City to Chicago, I have got to stretch that out along the floor. It will take more than one of us in a hurry. I know the stations en route that I have to look for between Atlantic City and Chicago. But one is going to be at that end, one in the middle; maybe another down here. The forecasts will be someplace else . . . by the time I get all this edited, I know there is no point in picking up the phone, because he is gone.

Operational problems have also been encountered by the users of the En Route Flight Advisory Service. One problem concerns lack of standardization of equipment and products from station to station, as AOPA testified:

> This is one of the confusing areas to pilots, that we get somewhat different service depending upon whether we are talking to the EFAS station in Atlanta or whether we are talking to the EFAS station in Washington. And the program of EFAS has not been completed from the standpoint that there are certain tools that were supposed to be put into the EFAS locations, such as satellite weather pictures and real-time radar information, and that is not complete yet. So when a pilot calls different EFAS locations, he may be getting something that is slightly different. And likewise, when he calls different control facilities, he is going to get something that may be different.

Another problem involves the blocking out of the EFAS frequency by high-altitude aircraft, causing lower altitude aircraft to lose transmission. The FAA has responded by implementing a separate frequency for high altitude aircraft on a test basis in the Southwest region. Hearing witnesses approved of this program, citing its value in allowing both low and high altitude flights to receive important weather information.

Several witnesses noted that GA pilots have difficulty reaching FSSs to receive preflight weather briefings and to file flight plans. Telephone lines are often busy, and the situation is particularly acute in bad weather when pilots have their greatest need for this information. In a special study for 1964–72, NTSB found that 28 percent of GA pilots involved in weather-related accidents had not received preflight briefings and that 62 percent had not filed flight plans.

Thus, testimony and supporting materials indicate that the Flight Service Station system that performs the crucial role of disseminating weather information to GA pilots is sorely deficient. A principal reason for this deficiency is that the FAA is starving the FSSs of funds, staff, and equipment, pending the automation of the whole system. This is creating poor morale, operating problems, and overloads in FSSs, and pilots are paying the price through inability to reach FSSs on the telephone for preflight briefings, variable quality services, inadequate briefings, poor communications en route, and the ensuing accidents.

AIRLINE DISPATCHERS

FAA regulations require airline dispatchers to relay all weather information of safety importance to pilots. The Transport Workers Union of America (TWUA) noted amended regulations which state that: "During a flight, the aircraft dispatcher shall provide the pilot in command any additional available information of meteorological conditions (including, as of December 31, 1977, adverse weather phenomena, such as clear air turbulence, thunderstorms, and low altitude wind shear), and irregularities of facilities and services that may affect the safety of flight."

Also, all certified carriers must submit a plan to the FAA detailing how they will acquire, process, and disseminate weather information to their crews.

In reality, however, most airline dispatchers spend the majority of their time providing preflight briefings rather than forwarding information during the en route phase. The Air Line Pilots Association (ALPA) testified during the hearings that 99 percent of a dispatcher's time is spent planning flights and 1 percent is spent following them.

This preflight preparation, according to the Flight Safety Foundation (FSF), "is a half-hour old or more by the time a flight leaves the ground. . . ." ALPA testified that weather briefings "aren't considered very accurate by pilots." With respect to en route information, ALPA indicated that "the quality of flight monitoring varies significantly from airline to airline, with some carriers having sophisticated systems allowing them to transmit current weather information to their flights in many parts of the world."

AIRLINE WEATHER SHOPS

At the time of our 1981 hearings, eight carriers provided their flights with en route weather information through in-house weather shops. Northwest Airlines, one of the eight, was represented at our hearing by its Superintendent of Meteorology, Mr. Daniel Sowa. He described Northwest's system as follows:

> In our weather shop, we have a drop on the circuits of the National Weather Service. These are circuits that send the coded radar data to the Kansas City Severe Storm Office of the National Weather Service. As they get the data, we get it. We plot it on a large board into our office, and encode the total picture on the radar into an encoded, very short message that is sent out to all our crews on our company radio circuit. This permits us to give the crews all the information on the ground based radar data in a manner that they find useful. . . . Every aircraft we operate must report to the company once an hour on the company circuit. As they do that they must tell me what type of flight it is, whether its a smooth ride, or what type of turbulence they are encountering, if any.

Despite this, General John Ralph of the Air Transport Association (ATA) rejected any correlation between air carriers with their own weather shops and increased safety.

With this in mind, Mr. Ramon Alvarez of the FAA was questioned as to why those carriers with weather shops would spend the extra money if they weren't increasing safety. He replied: "I would dare say that they have done a cost-benefit analysis and figured out that it is cost-beneficial to them. I think in the area of flight planning, figuring out the most cost-advantageous routes and altitudes for their fleet is probably their prime motivator."

At this point Chairman Levitas cited the New Hope, GA, aircrash wherein one air carrier with its own weather shop avoided severe weather conditions while another carrier, which did not have the service, flew through a severe storm cell. FAA acknowledged that carriers with their own weather shops "probably do a better job of analysis [of weather data] and of giving their own internal interpretation of that analysis to their pilots and their operating facilities."

Chairman Levitas responded:

> . . . it seems to me that what you said is probably at least a significant portion of the story, which has, again, at least two implications. The first and the one that is the most sensitive is that there is an implication there that an air carrier which has these services in addition to the direct services through the air control system may be in a better position to disseminate that information to its crews in a more timely fashion. That has the implication of making it a safer ride. What would you say about that?"
>
> Mr. ALVAREZ. On the face of it, I would have to agree with you.

The second implication cited by Chairman Levitas was that:

> . . . if Airline X has a meteorological service of its own, which either because of its analysis or whatever reason has information which they consider to be of critical importance to their crews, so much so that they disseminate it through their own system, why should they not provide the same information to FAA control, ARTCC centers. . . , and say: Look, we're advising our pilots of this information on our own; we just want to let you know that? So, someone in the air control system can make a judgement which says: Yes, that is pretty significant, and we'd like to pass that along to pilots in the area as well.

Mr. Alvarez responded that if this procedure wasn't already in effect, that FAA would try to get it implemented. This is an example of a simple procedural change that could be implemented immediately to improve the safety of the national airspace system.

DISPATCHERS, DEREGULATION, AND SAFETY

TWUA officials testified at our May 19, 1981 hearing that: "As a result of the new form of competition that the major carriers are facing, they are being driven to find means of reducing their costs and one of the areas they are looking at is meteorology."

The Flight Safety Foundation (FSF) witnesses shared that view, testifying that: "Airline deregulation, combined with economic

hard times, have brought about reductions in airline and government meteorology staffs".

TWUA officials proposed that: "Any scheduled operator who offers to haul passengers on a schedule for profit should provide that standard of safety that the major carriers are required to provide and if they are too small to equip and man it themselves they should purchase that service from an operator that is equipped and manned." They also called for either Congressional legislation or FAA regulation to eliminate the "double standard" for air safety in the varying types of commuter, air taxi, and certificated air carrier operations.

TWUA witnesses were very much opposed to the idea of airlines "flying without dispatchers and without meteorologists. . . ." They noted that there is a noticeable difference between the weather information supplied by the National Weather Service and that same data after it has been fine-tuned by dispatchers backed up by airline meteorologists. Mr. William G. Lindner remarked that "That is a double standard. I think the travelling public is being misled to believe that they are getting a single standard when they are not."

Mr. Lindner illustrated his point by presenting the scenario of a traveller buying a ticket for a major carrier that, due to deregulation, winds up with the last leg of the flight on a commuter airplane which doesn't have the same safety requirements.

Chairman Levitas asserted that: "There was never and still is not any intention to reduce safety for the travelling public as a result of deregulation." Mr. Levitas called attention to section 107(a) of the Airline Deregulation Act, which states that "Congress intends that the implementation of the Airline Deregulation Act of 1978 results in no diminution of the high standards of safety in the air transportation industry attained in the United States at the time of enactment of such act. . . ."

He also noted that Congress imposed new and more stringent requirements on commuter carriers, recognizing that there would be greater reliance placed on them by deregulation.

A related issue concerns the balancing of cost and safety by airlines. General Ralph testified that: "Safety is the first and most important consideration before the airlines, whether that consideration be related to design capabilities of equipment, training and proficiency of crews, or development of systems and procedures."

Testimony given by Captain Thomas Sheppard of ALPA, however, cast doubt upon General Ralph's assertion:

> Mr. ROEMER. Pursuing a recommendation that you made that makes good sense to me about the automatic data transmittal as the only method you foresee that the pilot can use—but until then, you recommend some sort of a dispatcher . . . . Would it take or require additional communications equipment to be installed?
>
> Captain SHEPPARD. I do not believe it would. I think where the cost would be, they might have to hire additional personnel in order to keep track of the flights.
>
> Mr. ROEMER. Do you think the old problem of balancing the cost and safety will affect your recommendation here?
>
> Captain SHEPPARD. Yes.

Mr. ROEMER. How do you foresee the conclusion of that? Do you think safety will win?

Captain SHEPPARD. No, I do not.

Captain Sheppard's view was shared by Mr. John O'Brien, also from ALPA, who noted that ". . . on several occasions, economic concerns have won out over safety concerns except where we have had a major disaster."

The subcommittee hopes that Capt. O'Brien and Capt. Sheppard are in error. However, based upon these hearings, we recognize the potential for aviation safety to be sacrificed in the face of economic concerns. This is clearly not the intent of Congress, and, given adequate FAA management, we trust that this will not occur.

THE AIR TRAFFIC CONTROL SYSTEM

The Air Traffic Control system disseminates weather information to pilots flying under instrument flight rules. All commercial air carriers operate under ATC system jurisdiction. The commercial air carriers also have company dispatchers and aircraft radar/visual observations to provide pilots with weather information. However, when IFR flights are en route, aircraft are in continuous contact with the traffic controllers and rely heavily upon them for real-time weather advisories. FAA testified that the principal duty of the controller is "to keep those aircraft apart from each other and also from the ground," and that a "secondary duty" is "to pass on any significant weather advisories" to pilots.

NEED FOR REAL-TIME WEATHER DISSEMINATION

James King, Chairman of the National Transportation Safety Board, stated that: "Weather information isn't getting to pilots consistently . . . this is due to the failure of the air traffic control system to disseminate weather information to air traffic controllers and pilots." The Flight Safety Foundation agreed, stating that "only in slack nighttime periods do controllers in high-volume ATC centers have the opportunity to informally participate in weather information transfer."

Mr. King cited two commercial accidents in which the ATC system failed to get information to an aircraft in a timely manner. In the fatal crash of Southern Airways DC–9 near New Hope, Georgia, in 1977, NTSB cited the failure of FAA's air traffic control system to provide timely dissemination of hazardous weather information to the flightcrew as a major contributing factor. Under circumstances that were "strikingly similar," the ATC system was again cited for dissemination failure in a 1980 Air Wisconsin accident taking 13 lives near Valley, Nebraska. In this accident the CWSU meteorologists were cited for failure to disseminate information to approach control supervisors.

NTSB elaborated on the need for real-time weather information transfer to pilots as follows:

> Rapid changes are possible in weather conditions, particularly the development and fast movement of the convective activity of severe thunderstorms and transient wind shear conditions. This makes it absolutely essential

> that those pilots who elect to, or who must by the nature of their operations, fly in the vicinity of unfavorable weather conditions, are kept aware of the actual weather along their route. . . . The ability to accomplish /this/ necessitates, first, the ability of the system to detect the real-time weather conditions, and, second, the ability of the system to communicate to the user the real-time weather conditions. By that, I mean the right now existing weather . . . which must be communicated to air traffic controllers so that they can plan the movements and possible changes in routing of flights under their control, and to the pilots of those flights who must make critical decisions based on that knowledge.

ATC PROVISION OF REAL-TIME WEATHER INFORMATION TO PILOTS

During the hearings, this subcommittee examined the flow of weather information within the ARTCC—from CWSU meteorologists who receive and interpret the NWS weather data to the controllers who use it to inform pilots—to gain an understanding of the dissemination process and its limitations.

The CWSU, added to the ATC system in 1978 following the Southern Airways weather-related accident, consists of NWS meteorologists who collect, screen, and interpret weather information, and develop an area forecast for that center's airspace. This information is disseminated both within the ARTCC to the controllers and outside the ARTCC to ATC towers and FSS specialists. The primary purpose of the CWSU is to improve the real-time weather information available to controllers and pilots.

In most centers, the CWSU unit is located near the flow controller's position at one end of the center. The unit is not readily accessible to the air traffic controllers' positions in the center of the facility, especially since controllers are not permitted to leave their positions unattended. In a few facilities, telephone lines have been added from controller positions to CWSU meteorologists on an experimental basis.

The CWSU meteorologist typically briefs the ARTCC supervisors at least once daily on forecasted weather. The supervisors, in turn, brief the controllers at the beginning of each shift, and, in theory, as often as is necessary during the shift.

When a SIGMET or other hazardous weather advisory is issued by NWS, it comes into the CWSU, is ripped off the teleprinter, and hand-carried to the weather service coordinator, who posts it in the appropriate control sectors (typically, not every SIGMET would apply to every ATC sector). After receiving the SIGMET, the controller broadcasts it either to all aircraft in his sector or to those aircraft which could be impacted as the weather cell traverses the center's airspace.

Each controller has a secondary radar scope channel at his position which depicts severe storm activity, shown as "H's" on the screen. Both NTSB and PATCO testified that this radar weather depiction was inadequate for controllers in comparison with the color radar to which the controller has no direct access.

Thus, the controller who has the full responsibility for informing pilots of hazardous weather conditions on a real-time basis does not have the best available weather radar, does not receive weather briefings directly from the CWSU meteorologists, is isolated from the meteorologists by the center layout, typically does not have telephone contact with the CWSU, and must receive hazardous weather advisories through management "channels." The CWSU meteorologists are required to communicate through the FAA's weather service coordinator (or supervisors in the case of briefings) in all forecasts and advisories affecting the ARTCC—often in a formal way.

OPERATIONAL PROBLEMS

How do these ATC weather communications work in practice? We did not get a full answer to this question, but testimony presented at the hearings indicated that operational problems exist.

Several FAA statements indicated that dissemination problems exist within the ATC system:

> Recent evaluations within the air traffic service have uncovered problems in some of the products and the dissemination procedures.
>
> So, yes, if a controller is handling maximum number of aircraft and he is busy flowing the traffic and separating airplanes, a weather advisory may get overlooked in the process; but that rarely happens.
>
> We also found that the SIGMET system that we use today is at times not always in concert with the process that we are using internally in the center, and we are looking for ways to make better use of the weather forecast that is being provided in the center . . . . Additionally, we found that because the system is relatively young, a lot of our flow controllers, supervisors, weather coordinators, did not have a complete understanding as to their role in the system, their responsibilities, et cetera.

The subcommittee probed the events surrounding the Air Wisconsin accident in Nebraska. The following FAA responses are indicative of specific operational problems:

> Our evaluation, as a result of the Nebraska crash, indicated that the information was available in the center facility. Because of a breakdown in our procedure itself, the information was not relayed to the controller to be relayed to the pilot.
>
> In the case of the day of the Air Wisconsin incident, the message was put into the in-box, the weather coordinators were busy helping the sectors do some flow-control work. As you can recall, that day there was weather activity, a lot of aircraft, and a high volume of traffic in the center at the time. They were busy helping the supervisors do flow-control functions. And they did not get back and focus in on the fact that they had a message there for some 40, 42 minutes. At that point they gave it to the meteorologist, who determines what sector should be getting the informa-

> tion, and then they made the dissemination. The Air Wisconsin was out of the system by then.
>
> The meteorologist in the center put the information in the air traffic control computer system, which relayed a message to Omaha approach control. Omaha approach control received the message about the time that the accident was occurring.

Based on FAA's statement above and corroborating statements by ATA, PATCO, and other knowledgeable witnesses, a disturbing picture begins to emerge with respect to pilot information dissemination. In hazardous weather situations affecting a major area (such as a line of thunderstorms) the ARTCC becomes an extremely busy place. The flow controller must decide on whether traffic patterns should be changed and, if so, how. The CWSU must provide weather information to support these important weather decisions. The weather coordinator, through whom the CWSU must communicate, is usually a flow controller performing in a secondary assignment; thus, his chief interest could be expected to be his flow control duties. As this flow control requirement becomes increasingly demanding because of the developing weather situation, it tends to absorb the time and energies of the CWSU and the weather service coordinator, *leading to less time and consideration devoted to the competing requirement—that of passing on hazardous weather information to the controllers for transmission to pilots.* Likewise, the controllers have an increasingly complex job in their primary function of separating and rerouting traffic under such conditions, and they, also *can be expected to have less time and effort available for communicating hazardous weather information to pilots.*

This strong impression of competing priorities applies also to high-traffic situations, as evidenced by testimony of the Flight Safety Foundation:

> It is possible to find en route controllers doing a commendable job in integrating weather information and verbally passing it on to pilots. However, if traffic volume increases these controllers necessarily cease their weather activities.

This situation is not limited to the ARTCC; it may be even more serious in the dissemination of hazardous weather information between the CWSU and the towers and FSSs. The CWSU has the responsibility for disseminating forecasts and advisories to these FAA units which are located elsewhere and to which communications are limited, as noted by FAA testimony:

> But, to be honest with you, we have some weaknesses in the distribution system and, at the present time, it is primarily done by manual means. The center weather service unit personnel have to pick up the phone and call the individual flight service stations or towers directly and pass the [weather] information on.

Thus, when weather conditions deteriorate over a broad area, the CWSU meteorologists are busy in the ARTCC (as described above) and may not have time to make the needed calls to the numerous

towers and FSSs within the ARTCC's boundaries. Further, the flow controllers in the towers have increased flow responsibilities in bad weather, and under high traffic conditions generally (just as within the ARTCC), and the controllers issue very time-constrained instructions to pilots; so that the transmission of weather information to pilots, if received by the tower, could be expected to receive a secondary priority.

The Flight Safety Foundation testimony supports this: Approach and departure controllers' "contact[s] with aircraft [are] relatively brief due to their limited area of surveillance and their function requiring intense activity to marshall and organize air traffic into the long lines that originate or terminate at a runway. Very little opportunity exists for approach controllers to deal with weather."

RECOMMENDATIONS OF WITNESSES FOR IMPROVEMENTS IN ATC DISSEMINATION

Several witnesses recommended improvements in ATC weather information dissemination:

> In summary, Mr. Chairman, PATCO asserts that the FAA must place immediate emphasis on management personnel to route weather information to air traffic controllers working positions in the most expeditious manner possible; that weather coordinator positions must be decombined from any nonrelated task and that those persons designated to handle the vital weather coordinator role be fully trained to do so; that the FAA directives regarding operation of the center weather service unit should be revised to allow controllers unrestricted access to briefings directly from the NWS meteorologists; and that color weather radar showing the six NWS echo intensity levels and coordinated with the controllers, air traffic display be provided at each radar sector in both the terminal and en route environment. (PATCO)
>
> Ultimately, we must continue to work toward the day when the air traffic control system will be able to display severe convective activity. We recognize the need for further hardware development, such as the microwave Doppler radars, and we are also informed that such hardware remains several years in the future.
>
> In the meantime, many of the accidents involve encounters with thunderstorms which are easily detectable by heavy precipitation on present weather radar equipment. We believe that immediate steps can be taken to use this information more effectively by procedural communication improvements. (NTSB)
>
> . . . perhaps at this point, it would be very appropriate for review of the procedures center-by-center to assure that the information is properly flowing from the National Weather Service to the center meteorologist and down to the line controller.
>
> In addition, we probably should look at the communications that exist between centers to make certain that information that is available to one center might be avail-

able to another center, especially if aircraft are transiting the center, and that the information is flowing from the center down through the various approach controls within the jurisdiction.

Also, it might be appropriate to look at the training of the controllers to make certain that they have full knowledge of the dynamics of severe weather, the various types of severe weather that can occur, what kind of conditions might prevail not only around the severe weather, but in a larger area. (Commuter Airline Association)

In the long term, the FAA should modify its ATC responsibility to include some degree of weather services, refine the role of the CWSUs to develop lines of horizontal and vertical weather communication, and somehow incorporate the center weather service unit type of information into approach control and control tower facilities.

In conclusion, we feel it important to stress that today's weather problem is not so much one of lack of basic information as failure to put that information where it is needed at the appropriate time. (Flight Safety Foundation)

Note that all of these witnesses are recommending immediate action to improve weather information dissemination such as training of weather coordinators and controllers, procedural communication/dissemination improvements, and locating color radar at the controller's station.

FAA's recommendations, on the other hand, were presented in terms of R&D systems in both 1981 and 1983: R&D will improve dissemination of weather information by the ATC system. FAA made little reference to more immediate actions, such as improved procedures and training. Neal Blake of FAA responded to the subcommittee's specific operational concerns as follows:

> I think the [R&D] programs I have described kind of address that problem, Mr. Chairman. . . .
>
> Yes, I am sure that the dissemination will improve as we are able to fund and implement these new systems.

The subcommittee is not convinced that R&D systems will, in the near future, provide the needed improvements in real-time dissemination; we are more confident in the recommendations for immediate action made by other witnesses.

Pilots

In our aviation system, pilots have the ultimate responsibility for making decisions regarding their aircraft, including when and how to take alternative action to avoid hazardous weather. Pilots use on-board radar and visual observation to identify weather conditions. They also have potentially available a range of weather forecasts and advisory data disseminated to aircraft from several ground sources. Despite these and other navigation aids, pilots have trouble obtaining weather information in a timely and useable manner.

General aviation pilots get most of their weather information from FAA's Flight Service Stations; commercial air carriers rely

primarily on FAA's air traffic control system, plus their own dispatchers. NWS's forecasting and advisory weather information is the foundation for both of these dissemination systems. (See Figure 1 in Introduction for a description of these information flows.)

The stages of flight serve to structure the weather information needs of pilots: flight planning, en route travel, and terminal landing/takeoff. In flight planning, the pilot needs an accurate, up-to-date forecast for the planned flight route. This helps him decide on the need for alternative routes, the desired flight altitude, how much fuel to take, and even whether the flight should be initiated at all in the event hazardous weather conditions are forecasted. Preflight weather briefings are conducted by dispatchers for commercial carriers and larger commuters, and by FSS specialists for most of general aviation.

During the en route and terminal phases, the pilot needs short-range forecasts and "right now" information on hazardous weather conditions, as such conditions are often subject to rapid, unpredictable changes. Although many aircraft are equipped with on-board radar, such equipment has limitations; thus, more sophisticated ground-based radar, reports from other pilots, and hazardous weather advisories must be communicated to pilots to augment the weather information. The ATC system, through its controllers in ARTCCs, TRACONs and towers, provides en route weather data to commercial carriers (supplemented, for some carriers, by dispatchers' en route information). En Route Flight Advisory Service (EFAS) personnel in FSSs have the same responsibility for general aviation. Weather broadcast systems also provide the information through HIWAS, ATIS, PATWAS, etc. The en route requirement for "right now" weather information is very crucial for most general aviation aircraft which seldom fly above hazardous weather as do commercial aircraft.

Witnesses expressed few complaints on the weather information received during preflight briefings. However, there was a strong and pervasive feeling that the "right now" information for the en route and terminal environments is, as an ALPA witness testified, "less than satisfactory, as the pilot flying today has little more in the way of real-time weather information available to him than his predecessor 20 years ago."

NTSB indicated that its accident records show that "important weather messages are often not received by the Flight Service Station briefer in a timely manner." A commuter airline representative testified that those commuter aircraft flying under the ATC system receive real-time weather information relative to the aircraft's position, but that those aircraft not flying under this system (i.e., those flying under VFR) receive information from the FSS and transcribed sources from which "severe weather . . . is always lagging behind in the system. What is reported now occurred 30 minutes ago." ALPA witnesses said that it takes too long to put information in the terminal information system (ATIS) to be useful to pilots faced with wind shear in the terminal area. Such "phenomena are so short-lived that by the time you have got the report out, this problem has gone away." The Flight Safety Foundation pointed to ATC difficulties in providing timely weather information to pilots in heavily traveled areas; the work load for controllers in

such areas is too heavy for them to have time to systematically pass on weather information to pilots. Also, "the approach and departure controllers are working usually in a very high-traffic-load situation. Sometimes, the work load is so high that conveyance of new weather information or critical weather information is virtually impossible."

Pilots usually have confidence in the reports of other pilots as a source of weather information; however, some witnesses questioned whether pilot reports are handled in a timely and effective manner. Chairman Levitas cited NTSB's investigation of a violent wind shear involved in the takeoff crash of a Pan Am flight from New Orleans International Airport. NTSB's investigation revealed that seven minutes before the Pan Am takeoff, a Republic Airlines flight had reported a wind shear encountered in takeoff to departure control. However, this PIREP was not communicated to controllers or flightcrews in the area.

Levitas indicated that a similar failure occurred with Eastern Flight 66 at Kennedy, and Clyne noted the World 30 flight at Boston.

Another witness cited the following reasons for, and consequences of, breakdowns in PIREP disposition in the ATC system:

> A shift change, no logging of this type of report, some problem in the computers—it all contributes to a possible hazard as far as the aviation community is concerned. The safety is in jeopardy.

Another issue raised during the hearings was the extent to which pilots can take alternative actions to avoid hazardous weather. NTSB testified that if a pilot requests an alternative route during the en route phase it is usually because this generally doesn't affect other traffic. However, comparable flexibility is lacking in the terminal area where time and distances are shortened and the number of available options is fewer. If a plane takes action to avoid weather, it may endanger other aircraft in the congested terminal area.

The hearings also identified a pilot awareness problem. For pilots unfamiliar with the power of weather or those who decide to fly in the face of hazardous weather, there is often an unsettling realization that the pilot is facing "situations that may tax his or her ability," stated a Flight Safety Foundation witness. The witness also cited an NTSB study indicating that "decisional errors account for a disproportionately large number of fatal accidents." The witness continued: "Correct and prudent decisions are more easily arrived at when time is available for consideration and full, accurate, and timely information on weather is available. Today, this is sometimes not the case."

NTSB pointed to a closely related problem, that of "deviation in the normal routine . . . that results in an accident." NTSB indicated that accidents frequently happen in the following manner:

> . . . very often it is some type of weather involvement, whether it be thunderstorm, whether it be wind shear, or merely a visibility or ceiling problem.

> This is where the situation varies from the norm, and the other factors involved in the accident become cascading effects, and that results in an accident. So weather is a factor in many of the accidents.

Witnesses' recommendations for improvement in the dissemination of weather information to pilots generally followed pragmatic concerns expressed at the hearings. Some excerpts follow:

Commuter Airline Association

> The third recommendation concerns the industry's role which, we believe, is the training and the knowledge of our pilots to make sure that they understand fully, first, the dynamics of severe weather, second, the various sources of information available to them in the cockpit, and third, the limitations associated with the use of radar.

Flight Safety Foundation

> In the short term, the Foundation feels that within the next year, a concerted attempt at weather education should be initiated. FAA coordination with aviation groups in the joint development of training programs aimed at the appropriate pilot population is essential.
>
> There is a lot of weather information in the system; sometimes we have a problem getting the individual who needs it to understand how to use it properly.

NTSB

> . . . many of the accidents involve encounters with thunderstorms which are easily detectable by heavy precipitation on present weather radar equipment. We believe that immediate steps can be taken to use this information more effectively by procedural communication improvements.

FAA's presentation at the hearings generally did not address training and educating pilots and short-term actions to facilitate dissemination of weather information to pilots. Instead, FAA's response to pilot informational needs typically involved R&D improvements for the future. The committee members probed this issue in several of our hearings, and FAA always responded to the effect that its Research and Development programs would eventually provide the needed weather information to pilots. But can we afford to wait?

The following introductory comment by Congressman Molinari, Ranking Minority Member, on Dec. 6, summarizes the subcommittee's impressions of the status of weather information from the pilot's perspective:

> As one who flies a great deal, the ability of the aircrews to receive the latest weather information is of great concern to me. I think that the record of aviation accidents is replete with instances where adverse weather conditions were well known to meteorologists and even air traffic controllers, but this information was never made available to the pilot of the aircraft. I think that the time is long

overdue when serious concern is given to insuring that this aviation related weather information is made available to the only one who needs to have it, namely the pilot of the aircraft. I know that this will take not only improved weather data collection equipment, but also a speedier means of collating and transmitting this information. Last, and I am sure just as important, is a clearly defined area of responsibility as to just who gives this information to the pilot. In the past it seems that this flow of information "dropped between the chairs" as someone in the pipeline decided that it wasn't his or her job.

CONCLUSIONS

This subcommittee concludes that the right-now-occurring (real-time) hazardous weather information is too often not reaching those responsible for taking evasive action—the pilots. In every weather-related airline accident reported at these hearings, somebody in the dissemination system knew of the hazard; but the individual who didn't know, in each case, was the pilot. This failure to disseminate known information was, likewise, the principal finding of our 1975 hearings; the problem has not disappeared. This section presents additional conclusions to support and amplify this principal one. Conclusions begin with weather observations and continue through the dissemination process in traffic control and Flight Service Stations and finally to pilots—just as weather information flows through the "system."

The system needed to observe microbursts and wind shear and to alert pilots in a timely manner now in Research and Development; present system partial

The most comprehensive microburst R&D effort to date is the Joint Airport Weather Study (JAWS) in Denver. JAWS found frequent microbursts; it developed and tested ways of measuring them and their effects on aircraft; and it tested aircraft detection and warning systems. Despite progress made by JAWS, this program is still in the R&D phase, and it will likely take several years before detection/alert systems are implemented at airports. In the meantime, the present alert/warning system (LLWSAS) is not yet implemented at all airports and it measures only wind shear at the airfield, leaving highly vulnerable approach and departure routes uncovered.

Weather observations to be enhanced by NEXRAD, problems remain for surface observation

NEXRAD—with implementation planned for 1988–92—is the next generation of weather radar and promises a significant improvement over present radar which has outlived its usefulness. In the meantime, color radar (RRWDS), which displays 6 levels of weather intensity, is being implemented (with delays) and provides a useful interim system. Automated surface observation systems, long in R&D, show promise of providing more regular weather observations at more airports compared to the present system of

human observers; however, it cannot describe factors such as runway conditions, cloud cover, and type of precipitation as well as humans can.

FAA's Research and Development program—more promise than delivery—yet billed as the key to improving weather information dissemination

Several times during the hearings, FAA officials promised to improve weather information dissemination, and consistently emphasized that Research and Development (R&D) was key to this. However, some of the most important R&D systems—NEXRAD, LLWSAS, color radar, FSS automation, and a high-speed traffic control communication system, NADIN—show little or no progress in implementation over the two and one half-year span of our hearings. In addition, safety-related operational problems are occurring in new systems. For example, the Hazardous Inflight Weather Advisory Service (HIWAS) provides hazardous weather messages to aircraft through a continuous weather broadcast as an alternative to providing weather through air traffic controllers. HIWAS was tested in the southern region, declared successful by FAA, and planned for immediate nationwide implementation. However, our hearings found that in a 1983 incident involving an Air Canada flight in this HIWAS test area, all of the 116 pilots surveyed after the incident were unaware of the HIWAS program. Problems such as this seem to result from FAA's failure to fully consider the operational circumstances of the pilots and their aircraft.

Present dissemination of weather information too complex to result in real-time notification of pilots

The present way of disseminating weather information to pilots has evolved over time without apparent design. This has resulted in a complex and cumbersome process that has many links at which the weather message or forecast can "fall through the cracks." Commercial air carriers can get real-time weather information through their own dispatchers, through several transcribed systems, through air traffic controllers, or through Flight Service Stations which primarily serve general aviation. Are these important redundancies or passive sources that count on one another to do the job of notifying pilots? Our hearings indicate that too often it appears to be the latter for reasons discussed in tne following sections.

Poor equipment, insufficient staffing, low morale, and passive services of the Flight Service Stations inadequate to meet the weather information needs of general aviation

Flight Service Stations (FSSs), numbering over 300 nationwide, provide most weather and pilot information to general aviation. However, the hearings found that the dissemination is deficient because the FAA has starved its FSSs of funds, staff, and equipment pending automation of the whole system—something that has been pending since 1970. This lack of support is creating poor morale and operating problems in the FSSs. As a consequence, pilots are

often unable to reach FSSs by telephone for important preflight weather briefings and for filing flight plans; pilots receive variable quality services; they sometimes encounter poor communication en route (such as voice override by the high-altitude aircraft); and, most dismaying, they sometimes do not receive hazardous weather messages available somewhere in the system—with potentially disastrous consequences.

Most airline dispatchers not providing weather advisories to their en route aircraft, despite the requirement by FAA; dispatchers doing so providing useful service

FAA regulations require that airline dispatchers provide en route weather information to their pilots. However, at the time of our 1981 hearings, only eight airlines were reported to use meteorological staffs to support dispatchers in providing this information. Testimony further indicated that airline dispatchers generally provided preflight weather briefings to their pilots but generally did *not* provide en route weather advisories. A meteorologist testified that his air carrier company had rerouted its aircraft around a severe line of thunderstorms; whereas, another carrier, without meteorologists, had not notified its pilots, one of whom ventured into the hazardous weather and crashed as a result. FAA acknowledged that it might be safer to fly on airlines having meteorologists, and that it might be beneficial if those airlines shared their weather information with others. Witnesses pointed to the general economic recession and to increased cost competition among airlines under deregulation as factors in the failure of airlines to have meteorological staff.

Competing demands for controller's time, lack of adequate weather radar at controller's station, the secondary priority of weather messages, and inadequate communications from the CWSUs among factors creating dissemination breakdowns in the ATC system

The Center Weather Service Unit (CWSU) is a group of NWS meteorologists located in FAA's Air Route Traffic Control Center (ARTCC) having the responsibility for analyzing and disseminating weather information both to controllers in the Center and to controllers in the FAA's region's towers and TRACONS. Controllers, in turn, have the responsibility for disseminating this information to pilots.

The controller's responsibility for disseminating weather information is secondary to that of separating aircraft; thus, when traffic work load is high, as in bad weather situations and in high traffic areas, the dissemination of weather information may be sacrificed for traffic control and aircraft rerouting. The competing pressures of traffic control were described by one witness after hearing a tape of approach control at New York's JFK airport: "The controller was talking continuously; there was obviously no way he could have relayed critical-weather-change information to all of the traffic that he was handling . . . and this was in good weather."

Controllers have limited weather detection equipment since the radar weather displays at their stations are inferior to color radar

available to the CWSU. Further, controllers seldom receive weather information directly from the CWSU, but must instead receive it indirectly through management channels in the ARTCC, which takes time and incurs the possible loss of data.

The CWSU typically telephones weather information to all terminal and approach/departure controllers under the ARTCC's jurisdiction—involving numerous calls that the CWSU may not always be able to make under the increased work load of bad weather.

Pilots not receiving accurate and timely real-time weather information from ground and sometimes having difficulty reacting to hazardous weather because of time constraints and lack of full awareness

Pilots have the ultimate responsibility for decisions to divert their aircraft to avoid hazardous weather. Their on-board radar has limitations relative to ground-based weather sources, but information from the ground is often outdated by the time pilots receive it from controllers, from FSS specialists, or from transcribed systems. Pilot weather reports are often delayed or even lost before being retransmitted to other pilots.

Wind shears or microbursts are short-lived phenomena which must be detected, and pilots alerted, within minutes of occurrence—a communication not often achieved. Thus, the real-time dissemination of known weather information remains a major problem facing aviation.

But the pilots themselves often need to learn better ways of handling hazardous weather situations. The Safety Board indicated that pilots often underestimate the power of weather and thus get into situations which sometimes lead to accidents. This is a problem that particularly arises in the terminal areas where the potential to avoid hazardous weather is limited due to heavy traffic and the vulnerable position of the aircraft. This is sometimes accentuated by the mental attitude among pilots favoring "getting in and landing" over evasive action. Thus, decisional errors account for numerous accidents, particularly among less experienced pilots in general aviation.

Recommendations

The subcommittee recommends that FAA and NWS strengthen appreciably the observations and, particularly, the dissemination of hazardous weather information to aviation. We expect a much greater emphasis on operational improvements to the dissemination systems so that, some day soon, we can say, for the first time: *the hazardous weather information was in the system somewhere, and it got through to the pilot in time to take evasive action.* We would like to stop at this general recommendation and let FAA/NWS carry it out; however, we have specific recommendations that contribute to this overall one. Further, we have some specific alternatives to FAA's position that R&D is the principal answer to dissemination problems; R&D hasn't improved dissemination noticeably in the past. There is little reason to believe it will do so in the future.

Air Traffic Control—Commercial Carriers

The subcommittee recommends that FAA make *either* the commercial air carriers *or* the Air Traffic Control system *responsible for* disseminating hazardous weather information to aircraft, and to provide the resources needed to carry out that responsibility. As it now stands, we cannot tell whether *both* dispatchers and controllers are responsible for providing hazardous weather information, or whether *neither* is responsible for doing this. The following are specific suggestions for enhancing the capabilities of air carriers if they are to assume the responsibility, or ATC (if it is to assume the responsibility).

Commercial Carriers

(1) Require that carriers have fully-qualified and aviation-trained meteorological groups to function much as the CWSUs; a smaller carrier would be encouraged to buy meteorological services or pool with other carriers;

(2) Equip the meteorological group with color radar and, ultimately, access to Doppler radar as it becomes available;

(3) Provide the group with full access to NWS forecasts/advisories;

(4) Require that these groups work closely with company dispatchers;

(5) Require dispatchers to maintain constant contact with their aircraft and to pass hazardous weather advisories on a real-time basis;

(6) Require that they transmit important pilot reports to their own aircraft and to other company dispatchers.

Air Traffic Control

(1) Increase the priority for transmitting hazardous weather information to pilots;

(2) Provide area supervisors with color radar and controllers with telephone access to the CWSU;

(3) Provide TRACONS with color radar and efficient NWS access;

(4) Train controllers/flow controllers/weather service coordinators to understand and to effectively disseminate weather messages to aircraft;

(5) Establish priorities for disseminating weather messages to pilots based on the severity of the hazards posed for aircraft;

(6) Expedite and improve the analysis, interpretation, and dissemination of pilot reports;

(7) Establish specific procedures and supporting resources for assuring that hazardous weather information is expedited in bad weather and high-volume traffic situations. At present there is evidence that such messages actually are less likely to get to pilots under these situations! These procedures might include adding sectors and/or adding controllers under high volume/bad weather conditions, and it might entail having selected controllers with the sole responsibility of disseminating hazardous advisories to all aircraft;

(8) Expedite coordination and transmission of weather information and messages among ARTCCS, towers, TRACONS, and FSSs.

Whether commercial carriers or air traffic control is given the prime responsibility for disseminating weather information, the other should continue to perform this function as a backup or supplement to the prime. The links between the prime and the backup should be clearly delineated. For example, even if commercial carriers assume the prime role, the ATC may still be the main source of pilot reports to be disseminated to the carrier dispatchers, and the CWSU would remain in place to assist flow controllers in rerouting traffic around weather and to inform controllers of weather forecasts and conditions.

For carrying out this recommendation, there is an important need to know how well the present dissemination system is working, e.g., where the breakdowns are. This could help to specify where resources are most importantly needed to shore up the system. This might require an operational review of ATC information dissemination by an independent organization, as follows:

Analyze the flow of information for the following settings:

Within ARTCC;

Within the tower/TRACON;

Between ARTCC/towers/TRACONS;

To pilots.

Analyze flow over a range of weather conditions, *and* a range of traffic conditions;

Set up conditions where ATC personnel *are not aware* of the review, so that they behave as they normally do.

Follow weather messages through the system to see whether they make it through or whether they encounter diversions or bottlenecks at certain points. It is at these points that FAA needs to concentrate its resources and remedies.

Perform the same kind of operational review for commercial carriers, both with and without meteorological groups.

Our hearings, and a related review of CWSU operations, identified innovative practices at some centers. The subcommittee recommends that FAA establish a forum for the full exchange of ideas and information among CWSUs. This might lead to improvements and eventual standardization of applicable activities.

Flight Service Stations

The subcommittee recommends that FAA assume responsibility for *actively* disseminating weather information to general aviation pilots through the Flight Service Stations. What is needed is a major reorientation of the FAA philosophy from that of passively waiting for pilots to contact the FSS (or to contact one of the transcribed weather services) to one in which FSS actively contacts pilots to disseminate weather messages. The implementation of this recommendation should be a challenge to FAA creativity. At this time, we can suggest types of approaches to take:

(1) The communications system should be developed to provide that all radio-equipped GA aircraft in a region are continually in touch with the FSS for weather messages/advisories

(as commercial carriers are in touch with ATC). These systems should be reserved for weather messages/emergencies.

(2) The Agency should consider development of a radar to better identify the location of GA aircraft. Ultimately, this could lead to the capability to separate GA aircraft from hazardous weather.

(3) To support real-time provision of weather information to aircraft on an active basis (as outlined in 1 and 2), the resources and the roles of FSSs need to be re-vamped. The preflight briefings and pilot reports should be computerized, releasing manpower and resources to providing en route information. The number of FSSs should be reduced substantially, but the resources per FSS should be increased significantly. Meteorological groups (similar to the CWSU) should be added to the FSSs. Training of staff should support all of this.

To carry out this recommendation, it is necessary to know how well the present GA dissemination is working, e.g. where the breakdowns occur. This might require a special review, by an independent organization, of information dissemination to GA pilots, as follows:

Analyze the flow of information reaching GA pilots:
What do they receive from transcribed services?
Do they file flight plans with the FSS?
Do they obtain preflight briefings from FSS?
Can they reach the FSS by telephone?
Do they get en route information from FSS?
When and how often? Are their pilots aware of this service?
What are other sources of weather information?
Analyze the flow of information through the FSS:
How is NWS data converted by FSS specialists into preflight briefings? Can, and should, this process be computerized to provide better service/more efficiency?
Is there evidence that telephone calls from pilots are not getting through?
What services do EFAS provide? When and how is the weather radar used?

Ideally, the review would analyze these flows over a range of both weather and traffic conditions, and would involve conducting both pilot and FSS analyses at the same time. In this way, the full FSS System can be evaluated by tracing the communication flow from FSS to pilots.

Research and Development

We recommend that FAA stop studying and start acting on its R&D programs. Improvement in weather information requires expeditious action on long-awaited projects such as NEXRAD (the next generation weather radar), FSS automation (to modernize the FSSs), JAWS (to detect microburst/wind shear and alert pilots), NADIN (high-speed communication for the ATC system), and Mode S data link (to provide weather displays in the cockpit). However, we suggest that FAA prioritize its R&D projects since all cannot be done on an equally timely basis and since those that can best im-

prove the dissemination of weather information are not being identified and expedited.

We also recommend that FAA implement operational improvements in dissemination, such as those suggested earlier in this section, since many of the dissemination bottlenecks uncovered in the hearings are operational in nature instead of requiring major R&D. Also, operational improvements provide a more immediate response to dissemination bottlenecks.

Finally, and most importantly, we recommend that FAA reorient its R&D program to be more responsive to the needs of pilots and their operational environment. This may require the use of pilot surveys to identify weather needs and the simulation of the pilots' operational environment to ensure that R&D contributes most effectively.

Oversight Foundation

We plan to use the recommendations and conclusions from this report as the principal basis for continued oversight of aviation weather. Thus, we suggest that FAA and NWS begin implementing these recommendations and responding to these conclusions, and be prepared to present progress reports at future oversight hearings.

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